Fall 2023

ME 315-003: Stress Analysis

Kwabena Narh

ME-315-003 STRESS ANALYSIS FALL 2023

Face-to-face: Day and Time: Thursday, Tuesday: 1:00 PM - 2:20 PM, Face-to-Face Room: MEC 221
Host: Prof. K. Albert Narh
Office Hours: Wednesday 2:00 PM - 3:00 PM, or via WebEx (login info njit.webex.com, Access code: 920 274 937).
T**here will be no office hours a day either before any scheduled exam or during the exam day.**

Textbook and Reference Book: See page 4:

Homework Homework Assignments are due one week after they are assigned.
Solutions to **SOME** homework problems will be reviewed in class. All Homework and Extra Credit Problems will be posted on canvas

NOTE: ***All homework and extra credit assignments must be submitted on the due date, unless there was prior excuse, which must go through the Dean of Students.***

Exams There will be three exams during the semester. There will be **NO** make-up exams.

NOTE: ALL EXAMS WILL BE VIA WEBEX AND WIL BE PROCTORED BY ME, YOUR INSTRUCTOR

Final Grade Composition: Course average is based on exams and homework.

Item	**Weight (%)**
Examination 1	30
Examination 2	30
Homework	10
Final Examination	30
	100
Extra Credit	*2 points (to be added to the Final Grade)*

Extra Credit Assignments:
Extra-Credit Assignments will be given periodically. There will also be extra-credits for class participation. These Extra-Credits are added to the final Grade Points.

Grading Scale A (90-100); B+ (85-89); B (80-84); C+ (75-79); C (70-74); D (55-69); F (<55)

ACADEMIC INTEGRITY
Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: *http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf*.
Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

I strongly recommend that you purchase and use a quality graphing calculator capable of performing algebraic manipulation for this course. A TI NSpire Cx-CAS is TI is top of the line calculator, and is fantastic for this course. The TI-89 Titanium is nearly as capable, somewhat cheaper, and quite a bit more available.

Week	Subject	Articles	Problems
1 9/5, 9/7 **2**	Introduction, Review of fundamentals: forces and their distributions on a body, Static analysis: Internal Moment Equations via Free-body diagrams		
9/12	Stress tensor	1.1 to 1.7	1.1, 1.2
9/14	Equilibrium equations, transformation of stresses, Principal stresses	1.8 to 1.10	1.13, 1.14, 1.21
3 9/19 9/23	Mohr's circle for stress Three-dimensional stresses	1.11 1.12 to 1.14	1.26, 1.27, 1.41 1.55, 1.66
4 9/26 9/28	Normal and shearing strains, strain tensor, compatibility Transformation of strains	2.1 to 2.4 2.5 to 2.6	2.1, 2.3, 2.5, 2.7 2.9, 2.15, 2.17
5 10/3	Engineering Materials, Stress-strain relations	2.7 to 2.10	2.36, 2.38, 2.40,
10/5	Strain gages		2.41, 2.42
6 10/12	Strain energy Saint Venant's principle	2.11 to 2.14	2.52, 2.54, 2.59, 2.66, 2.67
10/17	**Review of Exam 1**		
7	**Exam #1: 10/19/23/2023 Room MEC 221:** **Exam begins at 1:00pm; Exam ends at 2:20pm**		
8 10/26	Plane Problems: Plane stress, plane strain Airy stress function	3.1 to 3.4 3.5 to 3.6	3 .1a, 3.2, 3.3, 3.4 3.5, 3.8, 3.10, 3.16
10/31	Stress and strain in polar coordinates Stress concentration	3.8 to 3.9, 3.10 to 3.11	3.20, 3.24, 3.36
9 10/31 11/2	Failure theories Comparison of yielding criteria	4.1 to 4.8 4.9 to 4.12	4.4, 4.5 (Table D1), 4.6, 4.7, 4.9a, 4.10 4.25, 4.27a

10 11/7, 11/9 **10** 11/14	Axisymmetrically loaded members (Buckling) Shrink fit, composite cylinders. Rotating disks	8.1 to 8.4 8.5 8.6 to 8.8	8.1, 8.4, 8.6 (Eq. 8.14), 8.10, 8.11 (Eq. 8.18), 8.13 (Hk's law; Eq. 8.8), 8.21, 8.22, 8.32 (Fig. 8.11, and Ex. 8.5) 8.36 (Eq. 8.30), 8.37, 8.38, 8.39
11 11/14	Review of Exam #2	11/21	
12 11/21	Exam #2: 11/21/2023 Room MEC 221: @ 1:00pm	----	----
11/23	**11/23 Thanksgiving Recess Begins. No Classes**		
13 11/28, 11/30	Energy methods, Castigliano's Theorem Virtual Work, Ritz method	10.1 to 10.4 10.7 10.8 to 10.11	10.2, 10.3, 10.4, 10.5 10.41, 10.42, 10.43
14 12/5	Elastic stability of columns Actual columns	11.1 to 11.6 11.7 to 11.9	11.2 11.12, 11.13, 11.18, 11.21, 11.35
15 12/12	Review of Exam #2		
16	**Final Exam12/20/2023 11:00am-2:00am, KUPF208**		

Course Syllabus

<table>
<tr><td>COURSE NUMBER</td><td>ME 315</td></tr>
<tr><td>COURSE TITLE</td><td>Stress Analysis</td></tr>
<tr><td>COURSE STRUCTURE</td><td>(3-0-3) (lecture hr/wk - lab hr/wk – course credits)</td></tr>
<tr><td>COURSE COORDINATOR</td><td>A. D. Rosato</td></tr>
<tr><td>COURSE DESCRIPTION</td><td>This course provides the theoretical background to stress analysis in mechanical design. Topics include two-dimensional elasticity, transformation of stress and strain, plane stress and plane strain problems, axisymmetric members, buckling criteria and failure theories.</td></tr>
<tr><td>PREREQUISITE(S)</td><td>ME 215 – Engineering Materials and Processes; Mech 237 – Strength of Materials; Math 222 – Differential Equations</td></tr>
<tr><td>COREQUISITE(S)</td><td>None</td></tr>
<tr><td>REQUIRED, ELECTIVE, OR SELECTED ELECTIVE</td><td>Required</td></tr>
<tr><td>REQUIRED MATERIALS</td><td>Advanced Mechanics of Materials and Applied Elasticity 5th edition.by A.C Ugural and S.K. Fenster, Prentice Hall, 2012.</td></tr>
<tr><td>Materials (not Required)</td><td>Mechanics of Materials, R. Craig (Wiley), 3rd edition.
Power-point lecture notes provided by instructor</td></tr>
<tr><td>COMPUTER USAGE</td><td>MS Excel; MS Word for Homework Assignments</td></tr>
<tr><td>COURSE LEARNING OUTCOMES/ EXPECTED PERFORMANCE CRETERIA:</td><td>
<table>
<tr><td>Course Learning Outcomes</td><td>SOs*</td><td>Expected Performance Criteria</td></tr>
<tr><td>1 Use Mohr’s circle to fully analyze the stress/strain state in a body</td><td>1,2</td><td>Exam Question (80% of the students will earn a grade of 70% or better on this question)</td></tr>
<tr><td>2. Explain how Mohr’s circle is related to the stress transformation equations</td><td>1,2</td><td>Homework Assignment (80% of the students will earn a grade of 70% or better on this assignment)</td></tr>
<tr><td>3. Solve stress /strain eigenvalue problems</td><td>1,2</td><td>Exam Question (same as 1)</td></tr>
<tr><td>4. Apply various failure theories needed in the design process</td><td>1,2</td><td>Exam Question (
same as 1)</td></tr>
<tr><td>5. Explain and describe the relationship between stress and strain tensor</td><td>1</td><td>Homework Assignment (same as 2)</td></tr>
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	6. **Define** plane stress/ plane strain **Explain** Airy's Stress function for 2D problems	1	**Homework Assignment** (same as 2)
	7. **Develop** equations for and **solve** axisymmetric problems - plate with hole, point loads on a half-space	1	**Exam Question** (same as 1)
	8. **Solve** problems involving thick-walled cylinders, shrink-fits, and rotating disks	1,2	**Exam Question** (same as 1)
	9. **Describe** the concepts of strain energy, deformation work and explain Betti's reciprocity theorem	1	**Homework Assignment** (same as 2)
	10. **Explain** Castigliano's theorems and apply them to problems on beam deflections, and rotations	1,2	**Exam Question** (same as 1)
	11. **Apply** Castigliano's theorems to indeterminate structures	1,2	**Exam Question** (same as 1)
	12. **Explain** elastic stability related to column buckling	1,2	**Homework Assignment** (same as 2)
	13. **Solve** simple column buckling problems	1,2	**Exam Question** (same as 1)

CLASS TOPICS

1. Introduction, stress tensor; Equilibrium, transformation of stresses, principal stresses.
2. Mohr's circle for stress, Three-dimensional stresses.
3. Normal and shearing strains, strain tensor, compatibility, Transformation of strains.
4. Stress-strain relations.
5. Strain energy, St. Venant's principle.
6. Plane stress, plane strain, Airy stress function.
7. Stress & strain in polar coordinates, Stress concentration.
8. Axisymmetrically loaded members, Shrink fit, composite cylinders, rotating disks.
9. Theories of Failure.
10. Energy methods, Castigliano's Theorem, Virtual Work.
11. Elastic Stability of Columns.

STUDENT OUTCOMES (SCALE: 1-3)

1	2	3	4	5	6	7
3	3	-	-	-	-	-

3 – Strongly supported 2 – Supported 1 – Minimally supported

* Student Outcomes